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(71) Applicant: **TOYOTA MOTOR CORP**

(72) Inventor: **ITO KAZUHIRO**
TANAKA TOSHIAKI

(54) **EXHAUST EMISSION CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINE**

(57) Abstract:

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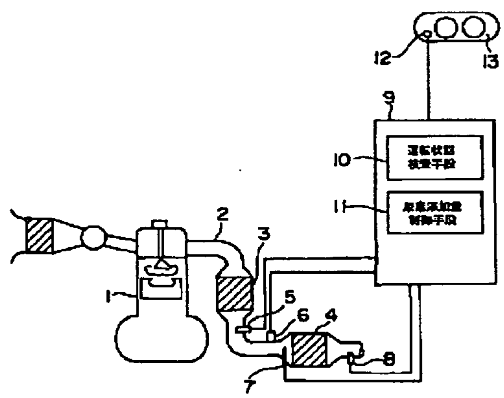

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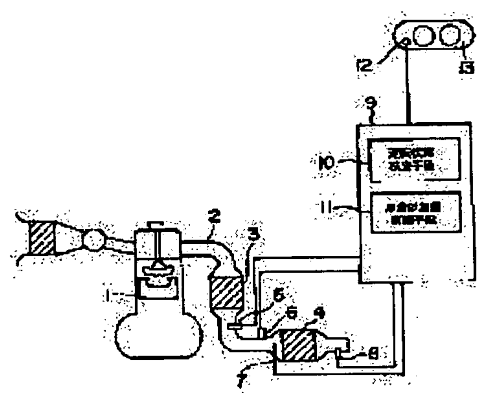

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CLAIMS

[Claim(s)]

[Claim 1] It is NOx when the air-fuel ratio of the exhaust gas discharged from the internal combustion engine by a lean combustion type internal combustion engine's flueway is Lean. NOx which carried out occlusion, and carried out occlusion when the oxygen density in exhaust gas fell NOx emitted and returned Exhaust emission control device of the internal combustion engine characterized by having an occlusion reduction type catalyst and the ammonium-compound selection reduction catalyst to which selection reduction is carried out by ammonium-compound addition.

[Claim 2] The operational status of the internal combustion engine which detected with said operational status detection means while having an operational status detection means to detect an internal combustion engine's operational status is followed, and it is said NOx. Exhaust emission control device of the internal combustion engine according to claim 1 characterized by having the means for switching which switches an exhaust gas style to either of an occlusion reduction type catalyst and an ammonium-compound selection reduction catalyst.

[Claim 3] Said NOx Exhaust emission control device of the internal combustion engine according to claim 1 or 2 characterized by having arranged the occlusion reduction type catalyst and said ammonium-compound selection reduction catalyst to the serial in the flueway.

[Claim 4] Said ammonium-compound selection reduction catalyst is set to a flueway, and it is said NOx. Exhaust emission control device of the internal combustion engine according to claim 3 characterized by having arranged to the downstream of an occlusion reduction type catalyst.

[Claim 5] Said ammonium-compound selection reduction catalyst is set to a flueway, and it is said NOx. Exhaust emission control device of the internal combustion engine according to claim 3 characterized by having arranged to the upstream of an occlusion reduction type catalyst.

[Claim 6] Said NOx Exhaust emission control device of the internal combustion engine according to claim 1 or 2 characterized by having arranged the occlusion reduction type catalyst and said ammonium-compound selection reduction catalyst to juxtaposition in the flueway.

[Claim 7] It is the exhaust emission control device according to claim 3 which is equipped with the bypass way which bypasses the catalyst arranged at the upstream and shows exhaust gas to the catalyst of the downstream, and is characterized by said means for switching switching an exhaust gas style by opening and closing a bypass way.

[Claim 8] A flueway is made to branch to the 1st parallel flueway and 2nd parallel flueway mutually, and it is said NOx to the 1st flueway. Exhaust emission control device of the internal combustion engine according to claim 6 characterized by having arranged the occlusion reduction type catalyst, having arranged said ammonium-compound selection reduction catalyst to the 2nd flueway, and having arranged the change-over valve as said means for switching at the branch point of said 1st flueway and 2nd flueway.

[Claim 9] NOx in the exhaust gas which flows into said ammonium-compound selection reduction catalyst Exhaust emission control device of an internal combustion engine given in either of claims 1-8 equipped with an addition ammonia combination amount-of-resources decision means to presume the ammonia combination amount of resources which should be added from an amount and an internal combustion engine's inhalation air content to said ammonium-compound selection reduction catalyst.

[Claim 10] The exhaust emission control device of the internal combustion engine having an ammonium-compound detection means to detect the ammonium compound which flows out of said ammonium-compound selection reduction catalyst, and the control means which corrects to a proper addition the ammonia combination amount of resources which should be added from the amount of ammonium-

compound detection detected with this ammonium-compound detection means according to claim 9.
[Claim 11] The exhaust emission control device of an internal combustion engine given in either of claims 1-10 equipped with the detection means and the ammonium-compound addition control means which fluctuates the ammonium-compound addition to an ammonium-compound selection reduction catalyst by whenever [catalyst temperature / which was detected] whenever [catalyst temperature / which detects the temperature condition of an ammonium-compound selection reduction catalyst].

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] NOx in the exhaust gas which this invention requires for an internal combustion engine's exhaust emission control device, and is especially discharged by the lean combustion-type internal combustion engine etc. -- it is related with the equipment to purify.
[0002]
[Description of the Prior Art] The equipment indicated by patent No. 2605580 is known as a lean combustion type internal combustion engine's exhaust emission control device.
[0003] This equipment is NOx when the air-fuel ratio of the flowing exhaust gas is Lean. NOx absorbed when it absorbs and the oxygen density of the flowing exhaust gas was reduced It is equipment which has arranged the NOx absorbent to emit to the flueway, and in order to reduce the oxygen density of exhaust gas, rich spike control which injects a fuel in an internal combustion engine and generates a unburnt gas (reducing agent) is performed. This is NOx. The reducing agent for purification is NOx at an internal combustion engine course. It means that an absorbent is supplied.
[0004]
[Problem(s) to be Solved by the Invention] Although there is a request that an internal combustion engine wants to operate in the state of Lean under high rotation and a heavy load by the case where it is a lean combustion type, with the exhaust emission control device which supplies a reducing agent from an internal combustion engine which described above, at such operational status, it is NOx about a reducing agent by rich spike. An absorbent (NOx catalyst) cannot be supplied.
[0005] In order to make an air-fuel ratio rich, it is necessary to extract a throttle and to reduce an inhalation air content, and when an internal combustion engine is operated by the high rotation heavy load and the Lean combustion, it is because trouble will cause combustion of a fuel and a smoke will occur, if such rich conditions are formed.
[0006] Then, although what is necessary is to give up the Lean combustion and just to perform combustion by SUTOIKI (theoretical air fuel ratio), improvement in the fuel consumption by the Lean combustion cannot be aimed at by making an internal combustion engine into a lean combustion type.
[0007] Moreover, at the selection reduction catalyst which uses such HC and H as a reducing agent although establishing the selection reduction catalyst which uses HC and H as a reducing agent is also considered, it is NOx in a high rotation heavy load condition because of an elevated temperature. The rate of purification is low.
[0008] It is NOx at an all operating range since it is such. It was difficult to purify. It was made in view of such a point, it compares with the former, and this invention is NOx at the largest possible operating range. The exhaust emission control device of the internal combustion engine which can purify is offered a technical problem.
[0009]
[Means for Solving the Problem] This invention took the following means in order to solve said technical problem. That is, the exhaust emission control device of the internal combustion engine of this invention is NOx when the air-fuel ratio of the exhaust gas discharged by a lean combustion type internal combustion engine's flueway from the internal combustion engine is Lean. NOx which carried out occlusion, and carried out occlusion when the oxygen density in exhaust gas fell It is characterized by having the NOx occlusion reduction type catalyst which emits and returns, and the ammonium-compound selection reduction catalyst to which selection reduction is carried out by ammonium-compound addition.
[0010] The internal combustion engine with which this invention is applied is the diesel power plant and

gasoline engine of a lean combustion type, and contains the engine of the injection type in a cylinder. NOx An occlusion reduction type catalyst is NOx when the internal combustion engine is operated under the Lean combustion of a high rotation heavy load. NOx absorbed by the absorbent Since it is not returned by the catalyst and an NOx absorbent is not returned, it is NOx. Purification becomes impossible. However, an ammonium-compound selection reduction catalyst functions under the service condition of a high rotation heavy load, and it is NOx. It purifies. Therefore, NOx It compares, when only an occlusion reduction type catalyst is established, and it is NOx. The operating range which can purify spreads.
[0011] In addition, NOx This invention was made on the assumption that the case where a reducing agent is supplied to an occlusion reduction type catalyst via an internal combustion engine, but even if it is equipment of the type which supplies a reducing agent to the flueway connected to the internal combustion engine, it does not interfere with applying this invention at all.
[0012] If it has the means for switching which switches an exhaust gas style to either of said NOx occlusion reduction type catalyst and an ammonium-compound selection reduction catalyst according to the operational status of the internal combustion engine which detected with said operational status detection means while having an operational status detection means to detect an internal combustion engine's operational status here, operational status is followed and it is NOx. The suitable catalyst for purification can be chosen.
[0013] For example, it is said NOx when the operational status detected with the operational status detection means is below a predetermined high rotation heavy load value. An occlusion reduction type catalyst is chosen, and when the detected operational status exceeds a predetermined high rotation heavy load value, an ammonium-compound selection reduction catalyst is chosen.
[0014] In addition, the operational status which should be detected is NOx. It is a operating range used as the reduction impossible field of an occlusion reduction type catalyst, and exhaust air purification by the ammonium-compound selection reduction catalyst is performed as reduction impossible here at the time of predetermined high rotation heavy load operational status. Therefore, in order to detect such operational status, they are NOx, such as an inhalation air content besides an engine rotational frequency, an engine load, or both sides, and throttle opening. The parameter which can show directly or indirectly the reduction impossible field of an occlusion reduction type catalyst can be used.
[0015] Here, it is said NOx. An occlusion reduction type catalyst and said ammonium-compound selection reduction catalyst can be arranged to a serial in a flueway. In this case, said ammonium-compound selection reduction catalyst is set to a flueway, and it is said NOx. You may arrange to the downstream of an occlusion reduction type catalyst, said ammonium-compound selection reduction catalyst is set to a flueway, and it is said NOx. You may arrange to the upstream of an occlusion reduction type catalyst.
[0016] Thus, when arranging to a serial, it is good to switch an exhaust gas style by having the bypass way which bypasses the catalyst arranged at the upstream and shows exhaust gas to the catalyst of the downstream, and opening and closing a bypass way by said means for switching.
[0017] Moreover, said NOx It is also possible to arrange an occlusion reduction type catalyst and said ammonium-compound selection reduction catalyst to juxtaposition in a flueway.
[0018] When arranging to juxtaposition, a flueway is made to branch to the 1st parallel flueway and 2nd parallel flueway mutually. It is said NOx to the 1st flueway. An occlusion reduction type catalyst is arranged and said ammonium-compound selection reduction catalyst is arranged to the 2nd flueway. As said means for switching A change-over valve is arranged at the branch point of said 1st flueway and 2nd flueway, and either of the 1st flueway and the 2nd flueway can be chosen by the change-over by the change-over valve according to an operation situation.
[0019] An operation situation is embraced by considering as the above configurations, and it is NOx. It functions in the form which an occlusion reduction type catalyst and an ammonium-compound selection reduction catalyst complement mutually, and suit. Therefore, as compared with the case of only one exhaust air purification catalyst, exhaust air purification can be performed by the wide range possible operating range.
[0020] Furthermore, NOx in the exhaust gas which flows into said ammonium-compound selection reduction catalyst If the exhaust emission control device which consists of said each configuration is equipped with an addition ammonia combination amount-of-resources decision means to presume the ammonia combination amount of resources which should be added from an amount and an internal combustion engine's inhalation air content to said ammonium-compound selection reduction catalyst, the ammonia combination amount of resources which should be added can be determined easily.
[0021] Furthermore, if it has an ammonium-compound detection means to detect the ammonium

compound which flows out of said ammonium-compound selection reduction catalyst, and the control means which corrects to a proper addition the ammonia combination amount of resources which should be added from the amount of ammonium-compound detection detected with this ammonium-compound detection means, the addition ammonia combination amount of resources can be controlled more correctly, and more effective exhaust air purification can be performed. In addition, a urea, ammonium carbamate, etc. are mentioned as an ammonium compound as a reducing agent used by the ammonium-compound selection reduction catalyst. Each configuration of this invention explained above can be combined as mutually as possible.

[0022]

[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained, referring to a drawing. In addition, in the following examples, it is the case where a urea is used as an ammonium compound.

[0023] The example shown in <operation gestalt 1> drawing 1 is NOx to the exhaust pipe 2 of the lean combustion type gasoline engine 1 which is an injection type in a cylinder. It is the example which has arranged the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4 as an ammonium-compound selection reduction catalyst to the serial, and the urea selection reduction catalyst 4 is NOx. It arranges to the downstream of the occlusion reduction type catalyst 3.

[0024] With this engine 1, fuel injection duration TAU is computed, for example based on a degree type. TAU=TP-K -- here, TP shows basic fuel injection duration and K shows the correction factor. The basic fuel injection duration TP shows fuel injection duration required to make into theoretical air fuel ratio the air-fuel ratio of the gaseous mixture supplied in an engine cylinder. This basic fuel injection duration TP is beforehand found by experiment, and is beforehand memorized in ROM in the form of a map as a function of engine load Q/N (inhalation air content Q / engine rotational frequency N) and the engine rotational frequency N.

[0025] A correction factor K is a multiplier for controlling the air-fuel ratio of the gaseous mixture supplied in an engine cylinder, and if it is K= 1.0, the gaseous mixture supplied in an engine cylinder will serve as theoretical air fuel ratio (SUTOIKI). On the other hand, if the air-fuel ratio of the gaseous mixture supplied in an engine cylinder will become larger than theoretical air fuel ratio if set to K< 1.0, namely, it becomes Lean and it is set to K> 1.0, the air-fuel ratio of the gaseous mixture supplied in an engine cylinder will become smaller than theoretical air fuel ratio, namely, will become rich.

[0026] And with this engine 1, Lean Air Fuel Ratio Control is performed at a load operating range in engine low, the value of a correction factor K being used as a value smaller than 1.0. SUTOIKI control is performed at the time of the warm-up at the time of engine heavy load operating-range and engine 1 starting, the value of a correction factor K being used as 1.0 at the time of acceleration and fixed-speed operation of 120 or more km/h. In an engine full load operating range, the value of a correction factor K is set up so that it may consider as a bigger value than 1.0 and rich Air Fuel Ratio Control may be performed.

[0027] in an internal combustion engine, the value of a correction factor K usually makes [in / the frequency by which low Naka load operation is carried out is the highest, therefore / most of an operation term throughout] it smaller than 1.0 -- having -- Lean -- gaseous mixture is made to burn

[0028] Said NOx The occlusion reduction type catalyst 3 makes an alumina support, and at least one chosen from Potassium K, Sodium Na, Lithium Li, alkali metal like Caesium Cs, Barium Ba, an alkaline earth like Calcium calcium, Lanthanum La, and rare earth like Yttrium Y and noble metals like Platinum Pt are supported on this support. An engine inhalation-of-air path and NOx It is NOx about the ratio of the air supplied in the flueway in the occlusion reduction type catalyst 3 upstream, and a fuel (hydrocarbon). It is this NOx when calling the air-fuel ratio of the inflow exhaust gas to the occlusion reduction type catalyst 3. The occlusion reduction type catalyst 3 is NOx when the air-fuel ratio of inflow exhaust gas is Lean. NOx which was absorbed, and was absorbed when the oxygen density in inflow exhaust gas fell It emits.

[0029] In addition, NOx When a fuel (hydrocarbon) or air is not supplied in the flueway of the occlusion reduction type catalyst 3 upstream, The air-fuel ratio of inflow exhaust gas is [therefore] in agreement with the air-fuel ratio of the gaseous mixture supplied to a combustion chamber. In this case NOx the time of the air-fuel ratio of the gaseous mixture by which the occlusion reduction type catalyst 3 is supplied to a combustion chamber being Lean -- NOx the gaseous mixture which absorbs and is supplied to a combustion chamber -- NOx absorbed when the inner oxygen density fell It emits and returns.

[0030] NOx NOx in the occlusion reduction type catalyst 3 It is thought that absorption and reduction are performed by the mechanism as shown in drawing 2 . Although this mechanism is the case where

Platinum Pt and Barium Ba are made to support on support, even if other noble metals, alkali metal, an alkaline earth, and rare earth are used for it, it turns into same mechanism.
[0031] First, since the oxygen density in exhaust gas will increase sharply if exhaust gas becomes Lean considerably, as it is shown in drawing 2 (A), it is oxygen O2. It adheres to the front face of Platinum Pt in the form of O2- or O2-. Next, NO contained in exhaust gas reacts with O2- or O2- on the front face of Platinum Pt, and is NO2. It becomes (2 NO+O2 ->2NO2).
[0032] Then, generated NO2 NOx NOx of the occlusion reduction type catalyst 3 Unless absorptance is saturated, as it is absorbed in a catalyst, it combines with the barium oxide BaO, oxidizing on Platinum Pt and it is shown in drawing 2 (A), it is NOx in the form of nitrate ion NO3-. It is spread in the occlusion reduction type catalyst 3. Thus, NOx NOx It is absorbed in the occlusion reduction type catalyst 3.
[0033] on the other hand, the case where the oxygen density in exhaust gas falls -- the amount of generation of NO2 -- falling -- a reaction contrary to said reaction -- NOx nitrate ion NO3- within the occlusion reduction type catalyst 3 -- NO2 or the form of NO -- NOx It is emitted from the occlusion reduction type catalyst 3.
[0034] That is, NOx It is NOx if the oxygen density in exhaust gas falls. It will be emitted from the occlusion reduction type catalyst 3. It will be NOx even if the air-fuel ratio of inflow exhaust gas will be Lean, if the oxygen density in inflow exhaust gas will fall if the Lean degree of inflow exhaust gas becomes low, therefore the Lean degree of inflow exhaust gas is made low, as shown in drawing 3 . The occlusion reduction type catalyst 3 to NOx It will be emitted.
[0035] the gaseous mixture supplied to a combustion chamber on the other hand at this time -- SUTOIKI -- or it is made rich -- having -- the air-fuel ratio of exhaust gas -- SUTOIKI -- or when it becomes rich, it is shown in drawing 3 -- as -- unburnt [a lot of] -- HC and CO are discharged from an engine 1. unburnt [these] -- HC and CO react immediately with oxygen O2- on Platinum Pt, or O2-, and oxidize.
[0036] Moreover, SUTOIKI or since [if it becomes rich,] the oxygen density in exhaust gas will fall to the degree of pole, the air-fuel ratio of inflow exhaust gas is NOx. The occlusion reduction type catalyst 3 is NO2. Or NO is emitted. this NO2 or NO is shown in drawing 2 (B) -- as -- unburnt -- it reacts with HC and CO and is returned. NO2 [thus,] on Platinum Pt or -- if NO stops existing -- the degree from the degree from a catalyst -- NO2 Or NO is emitted. Therefore, if the air-fuel ratio of inflow exhaust gas is made rich, it is NOx to the inside of a short time. The occlusion reduction type catalyst 3 to NOx It is emitted. even if it consumes O2- or O2- on Platinum Pt -- unburnt -- if HC and CO remain -- NOx NOx emitted from the occlusion reduction type catalyst 3 NOx discharged from the engine 1 unburnt [this] -- it is returned by HC and CO.
[0037] Therefore, if the air-fuel ratio of inflow exhaust gas is made rich, it will be NOx to the inside of a short time. NOx absorbed by the occlusion reduction type catalyst 3 It is emitted and, moreover, is this emitted NOx. Since it is returned, it is NOx in atmospheric air. It can prevent being discharged.
[0038] Moreover, NOx The occlusion reduction type catalyst 3 is NOx even if it makes the air-fuel ratio of inflow exhaust gas into theoretical air fuel ratio, since it has the function of a reduction catalyst. NOx emitted from the occlusion reduction type catalyst 3 It is returned. However, it is NOx when the air-fuel ratio of inflow exhaust gas is made into theoretical air fuel ratio. From the occlusion reduction type catalyst 3, it is NOx. Since deer emission is not carried out gradually, it is NOx. All NOx absorbed by the occlusion reduction type catalyst 3 Long time amount is required for emitting.
[0039] It will be NOx even if the air-fuel ratio of inflow exhaust gas will be Lean, if Lean's degree is made low for the air-fuel ratio of inflow exhaust gas. The occlusion reduction type catalyst 3 to NOx It is emitted. Therefore, NOx The occlusion reduction type catalyst 3 to NOx What is necessary is just to make the oxygen density in inflow exhaust gas fall, in order to make it emit.
[0040] Next, said urea selection reduction catalyst 4 is NOx. Urea addition performs selection reduction for a catalyst. NOx here A catalyst can illustrate the zeolite catalyst containing the oxide of the transition element of the 4th, 5, and 6 periods, and/or the oxide of rare earth. The catalyst which supported Ti and V to aluminum 2O3 can be illustrated especially preferably.
[0041] If a urea water solution is added on this catalyst, the nitrogen oxides under a predetermined exhaust-gas temperature and under exhaust air will be returned like the following reaction formulae.
[0042]
(NH2) 2 CO+H2O->2NH3 X+CO2 -- (1)
4NH(s)3X+4NO+O2->4N2+6H2O -- (2)
[0043] NOx explained above In order to operate mutually the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4 in complement, at this example, it is NOx. To the upstream of the urea selection reduction catalyst 4, it is NOx at the downstream of the occlusion reduction type catalyst 3. It

has the sensor 5 and the urea addition control valve 6. NOx A sensor 5 is NOx. It is the direct downstream of the occlusion reduction type catalyst 3, and is located in the upstream of the urea addition control valve 6. Moreover, while the catalyst close gas-temperature sensor 7 is arranged at the right above style side of the urea selection reduction catalyst 4, the ammonia sensor 8 is arranged at the downstream of the urea selection reduction catalyst 4.

[0044] NOx The sensor 5, the urea addition control valve 6, the catalyst close gas-temperature sensor 7, and the ammonia sensor 8 are electrically connected to the control unit (ECU) 9 which consists of a computer, respectively. Furthermore, the rotational frequency sensor for detecting an engine rotational frequency is formed, and this sensor is also connected to the control unit (ECU) 9.

[0045] As for condition ****** of each catalyst, an internal combustion engine's operational status is detected by the information from these sensors etc. And an operational status detection means 10 to detect an internal combustion engine's operational status from the data inputted from these sensors etc. is realized on the computer of said control unit (ECU) 9. Furthermore, while taking out a urea addition command to said urea addition control valve 6 according to the detected operational status, the urea addition control means 11 which controls an addition is also realized on the computer of said control unit (ECU) 9. In addition, when a urea is added by the urea addition control means 11, the reducing-agent indicator 12 displayed on an operator is formed [that the it is under addition, and] in 13, such as a meter panel.

[0046] NOx A sensor 5 is said NOx. The NOx concentration in the exhaust gas which went via the occlusion reduction type catalyst 3, i.e., NOx in the close gas to the urea selection reduction catalyst 4, Concentration is detected. Said urea addition control means 11 is NOx. NOx detected by the sensor 5 NOx discharged by the internal combustion engine by concentration and the air content detected by the air flow meter which is not illustrated NOx which calculated the amount and was calculated It has an amount decision means of addition ureas to presume the amount of ureas which should be added from an amount to the urea selection reduction catalyst 4, and it orders so that the urea of the amount according to the estimate may be added.

[0047] NOx detected here in order to presume the amount of ureas It is good to make ROM memorize the map which defined beforehand the relation between an amount and the amount of ureas which should be added. In addition, NOx The amount of EGR(s) according to accelerator opening as a result fuel oil consumption, an engine rotational frequency, and an EGR control unit instead of a sensor 5 etc. to NOx An amount may be presumed. Moreover, an internal combustion engine's inhalation air content is good in other means replaced with detection with an air flow meter, for example, throttle opening etc.

[0048] The catalyst close gas-temperature sensor 7 can function as a detection means whenever [catalyst temperature / which detects the temperature of the exhaust gas which flows into the urea selection reduction catalyst 4], and can judge the activated state of the urea selection reduction catalyst 4 from this temperature. Since the purification capacity of a catalyst is low when the close gas temperature to this catalyst is low, a urea addition is reduced in the urea addition control means 11. In addition, the relation between the close gas temperature (whenever [catalyst temperature]) to a catalyst and a urea addition is beforehand memorized to ROM as a map.

[0049] The ammonia sensor 8 is used for amendment of a urea addition. That is, it is NOx that the ammonia sensor 8 in the downstream of the urea selection reduction catalyst 4 detects ammonia. More than an amount, it means that there are too many added ureas. For this reason, it has the feedback control means which feeds back the amount of ammonia detection detected by the ammonia sensor 8 to the urea addition control means 11, and corrects to proper desired value the amount of ureas which should be added. This control means is also realized on the computer of a control unit (ECU) 9 as a part of urea addition control means 11.

[0050] Hereafter, the exhaust air purification control depended on this example is explained. If an internal combustion engine is operated, when a fuel burns within a cylinder, the gas which exhaust gas was discharged and was discharged flows the inside of an exhaust pipe 2, and is NOx. It passes along the muffler which carries out sequential passage and does not illustrate the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4, and is emitted to atmospheric air.

[0051] At this example, it is NOx. Exhaust air purification in the largest possible field is performed because the urea selection reduction catalyst 4 functions in the engine operating range of the heavy load quantity rotation beyond the purification field in the occlusion reduction type catalyst 3.

[0052] First, it is NOx when it is not a predetermined heavy load quantity rotation field. It is NOx at the principle described above in the occlusion reduction type catalyst 3. Occlusion and reduction change, and are carried out and exhaust air purification is performed. Namely, NOx The occlusion reduction type

catalyst 3 to NOx When emitted, the air-fuel ratio of inflow exhaust gas is made rich, and it is NOx. NOx emitted in the occlusion reduction type catalyst 3 It returns.
[0053] On the other hand, if a throttle is extracted, an inhalation air content is reduced and an air-fuel ratio is made rich when an internal combustion engine becomes predetermined heavy load quantity rotation, it will originate in an inhalation air content (the amount of oxygen) becoming less, a fuel will be in an unburnt condition, and the so-called smoke will occur. Therefore, at the operating range of predetermined heavy load quantity rotation, it is NOx. NOx depended occlusion reduction type catalyst 3 It cannot return.
[0054] Then, in response to the fact that the operational status detection means 10 detected that it was such a operating range, the urea addition control means 11 takes out a urea addition command to said urea addition control valve 6. From the urea addition control valve 6, a urea water solution is injected and, thereby, exhaust air purification is made by the above-mentioned principle.
[0055] It is NOx in the meantime. By the sensor 5, it is NOx. NOx blown without being purified with the occlusion reduction type catalyst 3 Concentration is detected, this detection value is received and the urea addition control means 11 of a control unit (ECU) 9 is NOx. Concentration, NOx discharged by the internal combustion engine by the inhalation air content to an internal combustion engine An amount is calculated, the amount of ureas which should be added from the value to the urea selection reduction catalyst 4 is presumed with the amount decision means of addition ureas, and the urea addition control valve 6 is ordered so that the urea of the amount according to the estimate may be added.
[0056] Moreover, the close gas temperature to the urea selection reduction catalyst 4 is measured by the catalyst close gas-temperature sensor 7, and a urea addition is fluctuated in the urea addition control means 11 of a control unit (ECU) 9 according to the height of the detection value.
[0057] Furthermore, the feedback control [in / in response to this detection value / it came out and the ammonia concentration in gas is detected, and / the urea addition control means 11] means to which the ammonia sensor 8 passed the urea selection reduction catalyst 4 corrects the amount of addition ureas in the direction whose ammonia concentration in the exhaust gas which passed the urea selection reduction catalyst 4 decreases.
[0058] Thus, NOx Although exhaust air purification is performed by the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4, it is NOx here. The complementary relationship of the exhaust air purification by the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4 is shown in drawing 4 . (A) in drawing 4 is NOx. The field by the occlusion reduction type catalyst 3 which can be purified is shown, and (B) in drawing 4 shows the field by the urea selection reduction catalyst 4 which can be purified.
[0059] Moreover, it is NOx to drawing 5 . The relation of the exhaust-gas temperature and the rate of purification in the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4 is shown. (A) of drawing 5 is NOx. The field by the occlusion reduction type catalyst 3 which can be purified is shown, and (B) in drawing 4 shows the field by the urea selection reduction catalyst 4 which can be purified. It is NOx in the field where an exhaust-gas temperature is low so that clearly from drawing 5 . It is understood that the occlusion reduction type catalyst 3 functions and the urea selection reduction catalyst 4 functions in the field where an exhaust-gas temperature is high.
[0060] In addition, it sets in this operation gestalt and is NOx. The location of the occlusion reduction type catalyst 3 and the urea selection reduction catalyst 4 may be exchanged.
[0061] Other operation gestalten are explained according to the <operation gestalt 2>, next drawing 6 . In drawing 6 , it is the configuration which equipped with the start cat 21 further the configuration shown with the operation gestalt 1. The start cat 21 is NOx prepared in the exhaust pipe 2 possible nearest to an internal combustion engine. It is the thing of a catalyst and is NOx at the time of engine starting. NOx taken out by the internal combustion engine before the occlusion reduction type catalyst 3 is warmed It purifies. The start cat 21 is NOx. Since it is arranged in the preceding paragraph of the occlusion reduction type catalyst 3 at the part near an internal combustion engine, it is promptly heated by exhaust gas at the time of an engine's starting, and a temperature up is carried out to a purification field.
[0062] In addition to the configuration shown in drawing 1 , the exhaust emission control device shown in this operation gestalt as shown in <operation gestalt 3> drawing 7 is NOx arranged at the upstream. It has the bypass way 31 which bypasses the occlusion reduction type catalyst 3 and shows exhaust gas to the catalyst of the downstream.
[0063] The change-over valve 32 which switches an exhaust gas style by opening and closing the bypass way 31 as a means for switching is formed in the junction of an exhaust pipe 2 and the bypass way 31.
[0064] This change-over valve 32 is a solenoid valve which is electrically connected to said control unit

(ECU) 9, and is controlled. And a change-over valve 32 is NOx by the operational status detection means 10. When it is the operating range on which the occlusion reduction type catalyst 3 functions, the bypass way 31 is closed, and it is NOx. It is made for exhaust gas to flow to the occlusion reduction type catalyst 3. Moreover, it is NOx, while detecting this condition and opening the bypass way 31 by the change-over valve 32, when an internal combustion engine will be in the operational status of heavy load quantity rotation. The exhaust gas path to the occlusion reduction type catalyst 3 is shut, and it is made for exhaust gas to have flowed into the direct urea selection reduction catalyst 4 from the bypass way 31.
[0065] Therefore, when the operational status of the internal combustion engine which detected with the operational status detection means 10 is not heavy load quantity rotation, A change-over valve 32 closes the bypass way 31 by the command from a control device. Exhaust gas to the NOx occlusion reduction type catalyst 3 A sink, When the operational status of the internal combustion engine which detected with the operational status detection means 10 is heavy load quantity rotation, a change-over valve 32 opens the bypass way 31 by the command from a control device, and it is NOx. The exhaust gas passage to the occlusion reduction type catalyst 3 is shut, and exhaust gas is passed from the bypass way 31 to the direct urea selection reduction catalyst 4. In response to the fact that the operational status detection means 10 detected that it was such a operating range, the urea addition control means 11 takes out a urea addition command to said urea addition control valve 6. From the urea addition control valve 6, a urea water solution is injected and, thereby, exhaust air purification is made by the above-mentioned principle.
[0066] A flueway is made to branch to the 1st parallel flueway 41 and 2nd parallel flueway 42 mutually, and the exhaust emission control device shown in this operation gestalt as shown in <operation gestalt 4> drawing 8 is NOx to the 1st flueway 41. It is the configuration which has arranged the occlusion reduction type catalyst and has arranged the urea selection reduction catalyst 4 to the 2nd flueway 42.
[0067] And the change-over valve 32 is arranged as said means for switching at the branch point of said 1st flueway 41 and 2nd flueway 42. And it is NOx like the configuration shown in drawing 1 . While the sensor 5 is formed in the upstream of urea selection reduction catalyst 4 **, the catalyst close gas-temperature sensor 7 is formed in the right above style side of the urea selection reduction catalyst 4, and the ammonia sensor 8 is formed in the downstream of the urea selection reduction catalyst 4. Furthermore, the urea addition control valve 6 is formed in the right above style side of the urea selection reduction catalyst 4.
[0068] Said change-over valve 32 is a solenoid valve which is electrically connected to said control unit (ECU) 9, and is controlled. And a change-over valve 32 is NOx by the operational status detection means 10. When it is the operating range on which the occlusion reduction type catalyst 3 functions, the 1st flueway 41 is chosen, and it is NOx. It is made for exhaust gas to flow to the occlusion reduction type catalyst 3. NOx Exhaust air purification with the occlusion reduction type catalyst 3 is as having described above.
[0069] Moreover, when an internal combustion engine will be in the operational status of heavy load quantity rotation, this condition is detected, a change-over valve 32 chooses the 2nd flueway 42, and it is made for exhaust gas to have flowed into the urea selection reduction catalyst 4. When the urea selection reduction catalyst 4 is chosen, the urea addition control means 11 takes out a urea addition command to said urea addition control valve 6. From the urea addition control valve 6, a urea water solution is injected and, thereby, exhaust air purification is made by the above-mentioned principle.
[0070] Gestalt] of operation of others [[ ] Although the example applied to the gasoline engine 1 explained this invention with the gestalt of operation mentioned above, of course, this invention is applicable to a diesel power plant. In the case of a diesel power plant, since combustion in a combustion chamber is performed in the Lean region farther than SUTOIKI, at the usual engine operational status, it is NOx. The air-fuel ratio of the exhaust gas which flows into the occlusion reduction type catalyst 3 is very Lean, and NOx. Although absorption is performed, emission of NOx is hardly performed.
[0071] Then, they are SUTOIKI or NOx which makes it rich and is absorbed by the catalyst about the air-fuel ratio of exhaust gas by introducing exhaust-gas-recirculation equipment (the so-called EGR equipment), for example, and introducing exhaust-gas-recirculation gas into a combustion chamber so much by the diesel power plant. It can be made to emit.
[0072]
[Effect of the Invention] NOx which according to the exhaust emission control device of the internal combustion engine of this invention complements an exhaust air purification field mutually and suits Since it had the occlusion reduction type catalyst and the ammonium-compound selection reduction catalyst, exhaust air purification by the largest possible operating range can be performed.
[0073] It has an operational status detection means to detect an internal combustion engine's operational

status here, an internal combustion engine's operational status is followed, and it is said NOx. By switching an exhaust gas style to either of an occlusion reduction type catalyst and an ammonium-compound selection reduction catalyst by the means for switching, the optimal catalyst can be chosen according to operational status.
[0074] Furthermore, NOx in the exhaust gas which flows into said ammonium-compound selection reduction catalyst with an addition ammonia combination amount-of-resources decision means From an amount and an internal combustion engine's inhalation air content, the ammonia combination amount of resources which should be added to an ammonium-compound selection reduction catalyst can be determined easily.
[0075] And an ammonium-compound detection means detects the ammonium compound which flows out of an ammonium-compound selection reduction catalyst, if the ammonia combination amount of resources which should be added from this detected amount of ammonium-compound detection is corrected to a proper addition by the control means, the addition ammonia combination amount of resources can be controlled more correctly, and more effective exhaust air purification can be performed.

[Translation done.]

* NOTICES *

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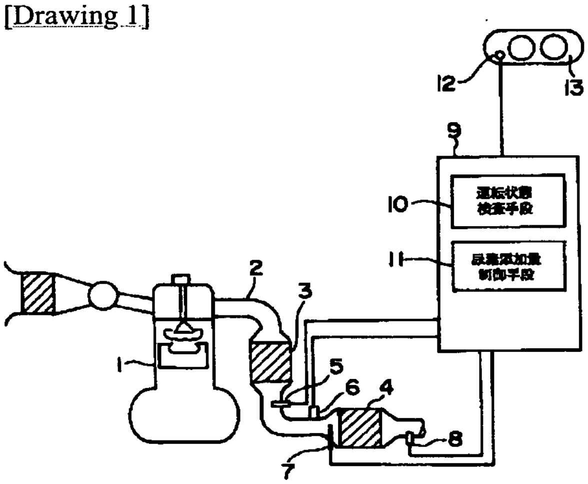
1.This document has been translated by computer. So the translation may not reflect the original precisely.

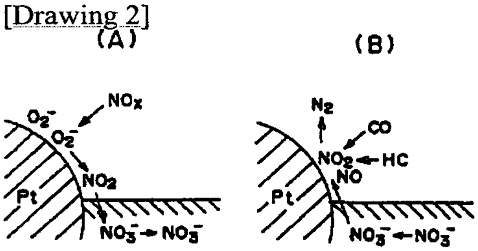
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

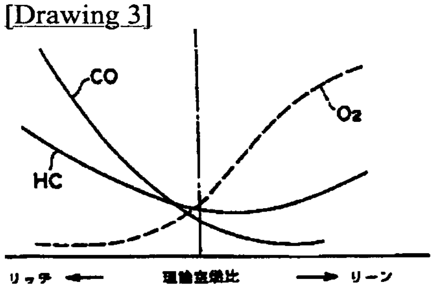
[Drawing 1]



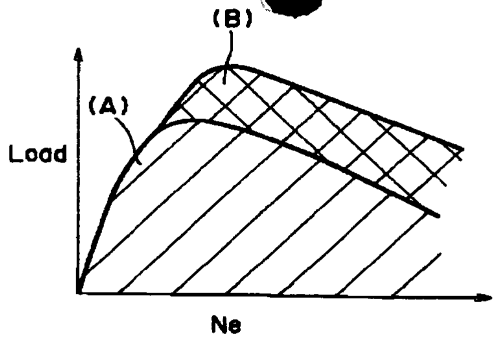
[Drawing 2]



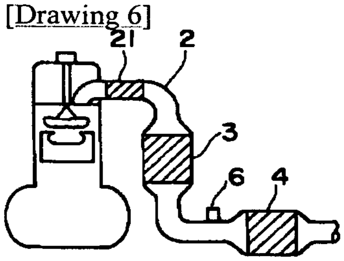
[Drawing 3]



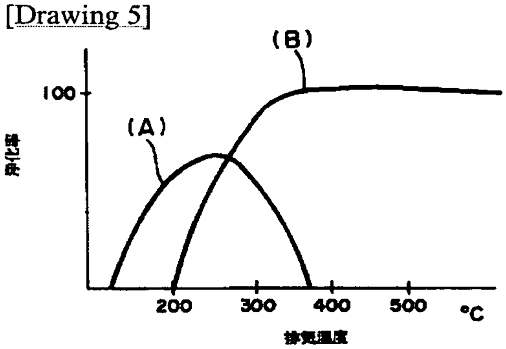
[Drawing 4]



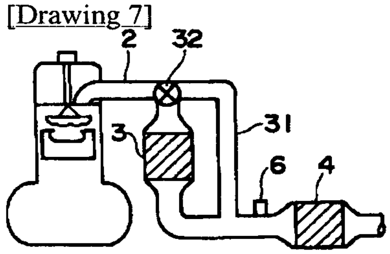
[Drawing 6]



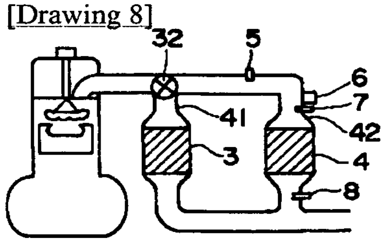
[Drawing 5]



[Drawing 7]



[Drawing 8]



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					３０１Ｈ	
Ｂ０１Ｄ	53/86	ＺＡＢ		3/08	Ａ	
	53/94				Ｂ	

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(71)出願人　000003207
トヨタ自動車株式会社
愛知県豊田市トヨタ町１番地

(72)発明者　伊藤　和浩
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内

(72)発明者　田中　俊明
愛知県豊田市トヨタ町１番地　トヨタ自動車株式会社内

(74)代理人　100089244
弁理士　遠山　勉　（外３名）

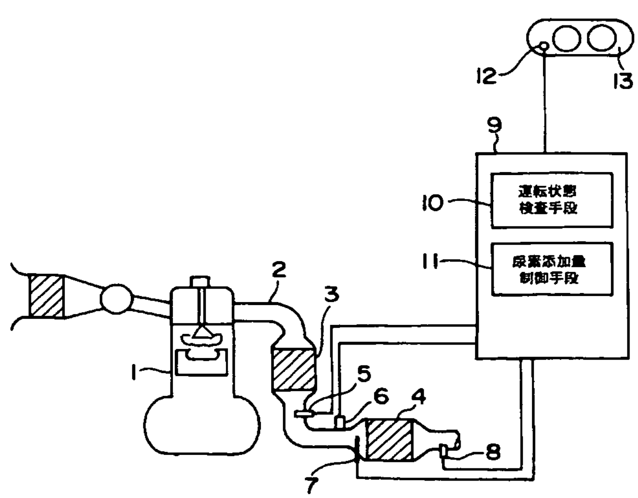
最終頁に続く

(54)【発明の名称】　内燃機関の排気浄化装置

(57)【要約】

【課題】従来に比べて可能な限り広い運転領域でＮＯx の浄化を行うことのできる内燃機関の排気浄化装置の提供を課題とする。

【解決手段】希薄燃焼式内燃機関の排気通路に、排気ガスの空燃比がリーンのときにＮＯx を吸蔵し、排気ガス中の酸素濃度が低下すると吸蔵したＮＯx を放出・還元するＮＯx 吸蔵還元型触媒３を設けるとともに、尿素添加により選択還元が行われる尿素選択還元触媒４とを備え、内燃機関のほぼ全運転領域での排気浄化を２つの触媒で互いに補完しながら行うようにした。



【特許請求の範囲】

【請求項１】　希薄燃焼式内燃機関の排気通路に、内燃機関から排出された排気ガスの空燃比がリーンのときにＮＯx を吸蔵し、排気ガス中の酸素濃度が低下すると吸蔵したＮＯx を放出・還元するＮＯx 吸蔵還元型触媒と、アンモニア化合物添加により選択還元が行われるアンモニア化合物選択還元触媒とを備えたことを特徴とする内燃機関の排気浄化装置。

【請求項２】　内燃機関の運転状態を検出する運転状態検出手段を備えるとともに、前記運転状態検出手段により検出した内燃機関の運転状態に従って、前記ＮＯx 吸蔵還元型触媒とアンモニア化合物選択還元触媒とのいずれか一方に排気ガス流を切り換える切換手段とを備えたことを特徴とする請求項１記載の内燃機関の排気浄化装置。

【請求項３】　前記ＮＯx 吸蔵還元型触媒と前記アンモニア化合物選択還元触媒とを排気通路に直列に配置したことを特徴とする請求項１または２記載の内燃機関の排気浄化装置。

【請求項４】　前記アンモニア化合物選択還元触媒を、排気通路において前記ＮＯx 吸蔵還元型触媒の下流側に配置したことを特徴とする請求項３記載の内燃機関の排気浄化装置。

【請求項５】　前記アンモニア化合物選択還元触媒を、排気通路において前記ＮＯx 吸蔵還元型触媒の上流側に配置したことを特徴とする請求項３記載の内燃機関の排気浄化装置。

【請求項６】　前記ＮＯx 吸蔵還元型触媒と前記アンモニア化合物選択還元触媒とを排気通路に並列に配置したことを特徴とする請求項１または２記載の内燃機関の排気浄化装置。

【請求項７】　上流側に配置された触媒を迂回して排気ガスを下流側の触媒に案内するバイパス路を備え、前記切換手段は、バイパス路を開閉することで排気ガス流を切り換えることを特徴とする請求項３記載の排気浄化装置。

【請求項８】　排気通路を互いに並列な第１の排気通路と第２の排気通路とに分岐せしめ、第１の排気通路に前記ＮＯx 吸蔵還元型触媒を配置し、第２の排気通路に前記アンモニア化合物選択還元触媒を配置し、前記切換手段として、切換弁を前記第１の排気通路と第２の排気通路との分岐点に配置したことを特徴とする請求項６記載の内燃機関の排気浄化装置。

【請求項９】　前記アンモニア化合物選択還元触媒に流入する排気ガス中のＮＯx 量と、内燃機関の吸入空気量とから前記アンモニア化合物選択還元触媒に添加すべきアンモニア化合物量を推定する添加アンモニア化合物量決定手段を備えた請求項１から８のいずれかに記載の内燃機関の排気浄化装置。

【請求項１０】　前記アンモニア化合物選択還元触媒から流出するアンモニア化合物を検出するアンモニア化合物検出手段と、このアンモニア化合物検出手段で検出したアンモニア化合物検出量から添加すべきアンモニア化合物量を適正な添加量に修正する制御手段とを備えた請求項９記載の内燃機関の排気浄化装置。

【請求項１１】　アンモニア化合物選択還元触媒の温度状態を検出する触媒温度検出手段と、検出した触媒温度によって、アンモニア化合物選択還元触媒へのアンモニア化合物添加量を増減するアンモニア化合物添加量制御手段とを備えた請求項１から１０のいずれかに記載の内燃機関の排気浄化装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は内燃機関の排気浄化装置に係り、特に、希薄燃焼式の内燃機関から排出される排気ガス中のＮＯx 等を浄化する装置に関する。

【０００２】

【従来の技術】希薄燃焼式内燃機関の排気浄化装置として、例えば、特許第２６０５５８０号に記載された装置が知られている。

【０００３】この装置は、流入する排気ガスの空燃比がリーンであるときにＮＯx を吸収し、流入する排気ガスの酸素濃度を低下させると吸収したＮＯx を放出するＮＯx吸収剤を排気通路に配置した装置であり、排気ガスの酸素濃度を低下させるために、内燃機関において燃料を噴射して未燃ガス（還元剤）を生成するリッチスパイク制御を行っている。このことは、ＮＯx の浄化のための還元剤が内燃機関経由でＮＯx 吸収剤へと供給されることを意味している。

【０００４】

【発明が解決しようとする課題】前記したような、内燃機関から還元剤を供給する排気浄化装置では、内燃機関が希薄燃焼式であった場合で、高回転、高負荷下においてもリーン状態で運転したいという要請があるものの、そのような運転状態ではリッチスパイクにより還元剤をＮＯx 吸収剤（ＮＯx 触媒）に供給することができない。

【０００５】空燃比をリッチにするためには、スロットルを絞って吸入空気量を減らす必要があるが、内燃機関が高回転高負荷かつリーン燃焼で運転されるときに、そのようなリッチ条件を形成すると燃料の燃焼に支障が来たし、スモークが発生するからである。

【０００６】そこで、リーン燃焼をあきらめストイキ（理論空燃比）での燃焼を行えばよいが、それでは内燃機関を希薄燃焼式としてリーン燃焼による燃費の向上を図ることができない。

【０００７】また、ＨＣやＨを還元剤とする選択還元触媒を設けることも考えられるが、そのようなＨＣやＨを還元剤とする選択還元触媒では高回転高負荷状態では、高温のためにＮＯx 浄化率が低い。

【０００８】このようなことから、全運転領域でＮＯx を浄化することが困難であった。本発明はこのような点に鑑みなされたもので、従来に比べて可能な限り広い運転領域でＮＯx の浄化を行うことのできる内燃機関の排気浄化装置の提供を課題とする。

【０００９】

【課題を解決するための手段】本発明は、前記課題を解決するため、以下の手段を採った。すなわち、本発明の内燃機関の排気浄化装置は、希薄燃焼式内燃機関の排気通路に、内燃機関から排出された排気ガスの空燃比がリーンのときにＮＯx を吸蔵し、排気ガス中の酸素濃度が低下すると吸蔵したＮＯx を放出・還元するＮＯx吸蔵還元型触媒と、アンモニア化合物添加により選択還元が行われるアンモニア化合物選択還元触媒とを備えたことを特徴とする。

【００１０】本発明が適用される内燃機関は希薄燃焼式のディーゼルエンジンやガソリンエンジンであり、筒内噴射式のエンジンを含む。ＮＯx 吸蔵還元型触媒は、内燃機関が高回転高負荷のリーン燃焼下で運転されているときＮＯx 吸収剤に吸収されたＮＯx が触媒によって還元されず、ＮＯx吸収剤が還元されないため、ＮＯx 浄化が不可能となる。しかし高回転高負荷の運転条件下では、アンモニア化合物選択還元触媒が機能し、ＮＯx を浄化する。よって、ＮＯx 吸蔵還元型触媒のみを設けた場合に比較して、ＮＯx 浄化を行える運転領域が広がる。

【００１１】なお、ＮＯx 吸蔵還元型触媒に還元剤を内燃機関経由で供給する場合を前提として本発明がなされたが、内燃機関に接続された排気通路に還元剤を供給するタイプの装置であっても、本発明を適用することには何ら差し支えない。

【００１２】ここで、内燃機関の運転状態を検出する運転状態検出手段を備えるとともに、前記運転状態検出手段により検出した内燃機関の運転状態に従って、前記ＮＯx吸蔵還元型触媒とアンモニア化合物選択還元触媒とのいずれか一方に排気ガス流を切り換える切換手段とを備えると、運転状態に従ってＮＯx 浄化に適切な触媒を選択できる。

【００１３】例えば、運転状態検出手段で検出した運転状態が所定の高回転高負荷値以下のとき、前記ＮＯx 吸蔵還元型触媒を選択し、検出した運転状態が所定の高回転高負荷値を越えたとき、アンモニア化合物選択還元触媒を選択する。

【００１４】なお、検出すべき運転状態とは、ＮＯx 吸蔵還元型触媒の還元不能領域となる運転領域であり、ここでは所定の高回転高負荷運転状態のときに還元不能としてアンモニア化合物選択還元触媒による排気浄化を行う。よって、このような運転状態を検出するためには、機関回転数、機関負荷のいずれかあるいは双方の他、吸入空気量、スロットル開度など、ＮＯx 吸蔵還元型触媒の還元不能領域を直接的あるいは間接的に示すことのできるパラメータを用いることができる。

【００１５】ここで、前記ＮＯx 吸蔵還元型触媒と前記アンモニア化合物選択還元触媒とを排気通路に直列に配置することができる。この場合、前記アンモニア化合物選択還元触媒を、排気通路において前記ＮＯx 吸蔵還元型触媒の下流側に配置してもよいし、前記アンモニア化合物選択還元触媒を、排気通路において前記ＮＯx 吸蔵還元型触媒の上流側に配置してもよい。

【００１６】このように直列に配置する場合、上流側に配置された触媒を迂回して排気ガスを下流側の触媒に案内するバイパス路を備え、前記切換手段によってバイパス路を開閉することで排気ガス流を切り換えるようにするとよい。

【００１７】また、前記ＮＯx 吸蔵還元型触媒と前記アンモニア化合物選択還元触媒とを排気通路に並列に配置することも可能である。

【００１８】並列に配置する場合、排気通路を互いに並列な第１の排気通路と第２の排気通路とに分岐せしめ、第１の排気通路に前記ＮＯx 吸蔵還元型触媒を配置し、第２の排気通路に前記アンモニア化合物選択還元触媒を配置し、前記切換手段として、切換弁を前記第１の排気通路と第２の排気通路との分岐点に配置し、運転状況に応じて切換弁による切換で第１の排気通路と第２の排気通路とのいずれかを選択するようにすることができる。

【００１９】以上のような構成とすることで、運転状況に応じて、ＮＯx 吸蔵還元型触媒とアンモニア化合物選択還元触媒とが互いに補完しあう形で機能する。従って、一方の排気浄化触媒だけの場合に比較して、可能な限り広範囲の運転領域で排気浄化を行うことができる。

【００２０】さらに、前記アンモニア化合物選択還元触媒に流入する排気ガス中のＮＯx 量と、内燃機関の吸入空気量とから前記アンモニア化合物選択還元触媒に添加すべきアンモニア化合物量を推定する添加アンモニア化合物量決定手段を前記各構成からなる排気浄化装置に備えると、添加すべきアンモニア化合物量を容易に決定できる。

【００２１】さらに、前記アンモニア化合物選択還元触媒から流出するアンモニア化合物を検出するアンモニア化合物検出手段と、このアンモニア化合物検出手段で検出したアンモニア化合物検出量から添加すべきアンモニア化合物量を適正な添加量に修正する制御手段を備えれば、より正確に添加アンモニア化合物量を制御することができ、より効果的な排気浄化を行うことができる。なお、アンモニア化合物選択還元触媒で使用する還元剤としてのアンモニア化合物としては、尿素、カルバミン酸アンモニウム等が挙げられる。以上説明した本発明の各構成は、可能な限り互いに組み合わせることができる。

【００２２】

【発明の実施の形態】以下、本発明の実施形態を図面を

参照しつつ説明する。なお、以下の例では、アンモニア化合物として尿素を使用した場合である。

【００２３】<実施形態１>図１に示した例は、筒内噴射式である希薄燃焼式ガソリンエンジン１の排気管２に、NOx 吸蔵還元型触媒３とアンモニア化合物選択還元触媒としての尿素選択還元触媒４とを直列に配置した例であり、尿素選択還元触媒４はNOx 吸蔵還元型触媒３の下流側に配置してある。

【００２４】このエンジン１では、例えば次式に基づいて燃料噴射時間ＴＡＵが算出される。

ＴＡＵ＝ＴＰ・Ｋ

ここで、ＴＰは基本燃料噴射時間を示しており、Ｋは補正係数を示している。基本燃料噴射時間ＴＰは機関シリンダ内に供給される混合気の空燃比を理論空燃比とするのに必要な燃料噴射時間を示している。この基本燃料噴射時間ＴＰは予め実験により求められ、機関負荷Ｑ／Ｎ（吸入空気量Ｑ／機関回転数Ｎ）および機関回転数Ｎの関数として、マップの形で予めＲＯＭ内に記憶されている。

【００２５】補正係数Ｋは機関シリンダ内に供給される混合気の空燃比を制御するための係数であって、Ｋ＝１．０であれば機関シリンダ内に供給される混合気は理論空燃比（ストイキ）となる。これに対してＫ＜１．０になれば機関シリンダ内に供給される混合気の空燃比は理論空燃比よりも大きくなり、すなわちリーンとなり、Ｋ＞１．０になれば機関シリンダ内に供給される混合気の空燃比は理論空燃比よりも小さくなり、すなわちリッチとなる。

【００２６】そして、このエンジン１では、機関低中負荷運転領域では補正係数Ｋの値が１．０よりも小さい値とされてリーン空燃比制御が行われ、機関高負荷運転領域、エンジン１始動時の暖機運転時、加速時、および例えば１２０ｋｍ／ｈ以上の定速運転時には補正係数Ｋの値が１．０とされてストイキ制御が行われ、機関全負荷運転領域では補正係数Ｋの値は１．０よりも大きな値とされてリッチ空燃比制御が行われるように設定してある。

【００２７】内燃機関では通常、低中負荷運転される頻度が最も高く、従って、運転期間中の大部分において補正係数Ｋの値が１．０よりも小さくされて、リーン混合気が燃焼せしめられることになる。

【００２８】前記NOx 吸蔵還元型触媒３は、例えばアルミナを担体とし、この担体上に例えばカリウムＫ、ナトリウムＮａ、リチウムＬｉ、セシウムＣｓのようなアルカリ金属、バリウムＢａ、カルシウムＣａのようなアルカリ土類、ランタンＬａ、イットリウムＹのような希土類から選ばれた少なくとも一つと、白金Ｐｔのような貴金属とが担持されている。機関吸気通路およびNOx 吸蔵還元型触媒３上流での排気通路内に供給された空気および燃料（炭化水素）の比をNOx 吸蔵還元型触媒３

への流入排気ガスの空燃比と称するとき、このNOx 吸蔵還元型触媒３は、流入排気ガスの空燃比がリーンのときはNOx を吸収し、流入排気ガス中の酸素濃度が低下すると吸収したNOx を放出する。

【００２９】なお、NOx 吸蔵還元型触媒３上流の排気通路内に燃料（炭化水素）あるいは空気が供給されない場合、流入排気ガスの空燃比は燃焼室内に供給される混合気の空燃比に一致し、従って、この場合には、NOx 吸蔵還元型触媒３は燃焼室内に供給される混合気の空燃比がリーンのときには、NOx を吸収し、燃焼室内に供給される混合気中の酸素濃度が低下すると吸収したNOx を放出・還元する。

【００３０】NOx 吸蔵還元型触媒３でのNOx 吸収・還元は、図２に示したようなメカニズムで行われると考えられている。このメカニズムは、担体上に白金ＰｔおよびバリウムＢａを担持させた場合であるが、他の貴金属，アルカリ金属，アルカリ土類，希土類を用いても同様のメカニズムとなる。

【００３１】まず、排気ガスがかなりリーンになると排気ガス中の酸素濃度が大巾に増大するため、図２（Ａ）に示すように酸素O_2 がO_2^-またはO^{2-}の形で白金Ｐｔの表面に付着する。次に、排気ガスに含まれるＮＯは、白金Ｐｔの表面上でO_2^-またはO^{2-}と反応し、NO_2 となる（$2NO+O_2 \rightarrow 2NO_2$）。

【００３２】その後、生成されたNO_2 は、NOx 吸蔵還元型触媒３のNOx 吸収能力が飽和しない限り、白金Ｐｔ上で酸化されながら触媒内に吸収されて酸化バリウムＢａＯと結合し、図２（Ａ）に示されるように硝酸イオンNO_3^-の形でNOx 吸蔵還元型触媒３内に拡散する。このようにしてNOx がNOx 吸蔵還元型触媒３内に吸収される。

【００３３】これに対し、排気ガス中の酸素濃度が低下した場合は、NO_2の生成量が低下し、前記反応とは逆の反応によって、NOx 吸蔵還元型触媒３内の硝酸イオンNO_3^-は、NO_2 またはＮＯの形でNOx 吸蔵還元型触媒３から放出される。

【００３４】つまり、NOx は、排気ガス中の酸素濃度が低下すると、NOx 吸蔵還元型触媒３から放出されることになる。図３に示されたように、流入排気ガスのリーン度合いが低くなれば、流入排気ガス中の酸素濃度が低下し、従って、流入排気ガスのリーン度合いを低くすれば、たとえ流入排気ガスの空燃比がリーンであってもNOx 吸蔵還元型触媒３からNOx が放出されることとなる。

【００３５】一方、このとき、燃焼室内に供給する混合気がストイキあるいはリッチにされて、排気ガスの空燃比がストイキあるいはリッチになると、図３に示すように多量の未燃ＨＣ，ＣＯがエンジン１から排出される。これら未燃ＨＣ，ＣＯは、白金Ｐｔ上の酸素O_2^-またはO^{2-}とすぐに反応して酸化される。

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【００３６】また、流入排気ガスの空燃比がストイキあるいはリッチになると、排気ガス中の酸素濃度は極度に低下するため、ＮＯx 吸蔵還元型触媒３は、NO_2 またはＮＯを放出する。このNO_2 またはＮＯは、図２（Ｂ）に示すように、未燃ＨＣ、ＣＯと反応して還元される。このようにして白金Ｐｔ上のNO_2 またはＮＯが存在しなくなると、触媒から次から次へとNO_2 またはＮＯが放出される。従って、流入排気ガスの空燃比をリッチにすると短時間の内にＮＯx 吸蔵還元型触媒３からＮＯx が放出される。白金Ｐｔ上のO_2^-またはO^{2-}を消費しても未燃ＨＣ，ＣＯが残っていれば、ＮＯx 吸蔵還元型触媒３から放出されたＮＯx も、エンジン１から排出されたＮＯx も、この未燃ＨＣ，ＣＯによって還元される。

【００３７】従って、流入排気ガスの空燃比をリッチにすれば短時間の内にＮＯx 吸蔵還元型触媒３に吸収されているＮＯx が放出され、しかも、この放出されたＮＯx が還元されるために大気中にＮＯx が排出されるのを阻止することができる。

【００３８】また、ＮＯx 吸蔵還元型触媒３は還元触媒の機能を有しているので、流入排気ガスの空燃比を理論空燃比にしてもＮＯx 吸蔵還元型触媒３から放出された＊＊ＮＯx が還元される。しかし、流入排気ガスの空燃比を理論空燃比にした場合、ＮＯx 吸蔵還元型触媒３からはＮＯx が徐々にしか放出されないため、ＮＯx 吸蔵還元型触媒３に吸収されている全ＮＯx を放出するには長い時間を要する。

【００３９】流入排気ガスの空燃比をリーンの度合いを低くすればたとえ流入排気ガスの空燃比がリーンであったとしても、ＮＯx 吸蔵還元型触媒３からＮＯx が放出される。従って、ＮＯx 吸蔵還元型触媒３からＮＯx を放出させるには、流入排気ガス中の酸素濃度を低下させればよいこととなる。

【００４０】次に、前記尿素選択還元触媒４は、ＮＯx 触媒に尿素添加により選択還元を行うものである。ここでいうＮＯx 触媒は、第４、５および６周期の遷移元素の酸化物および／または希土類の酸化物を含有するゼオライト触媒を例示できる。特に好ましくは、Al_2O_3にＴｉ、Ｖを担持した触媒が例示できる。

【００４１】この触媒上に尿素水溶液が添加されると、所定の排気温度下、排気中の窒素酸化物が以下の反応式のように還元される。

【００４２】

$$(NH_2)_2CO + H_2O \rightarrow 2NH_3^x + CO_2 \quad \cdots (1)$$

$$4NH_3^x + 4NO + O_2 \rightarrow 4N_2 + 6H_2O \quad \cdots (2)$$

【００４３】以上説明した、ＮＯx 吸蔵還元型触媒３と尿素選択還元触媒４とを互いに補完的に機能させるため、本例では、ＮＯx 吸蔵還元型触媒３の下流側で尿素選択還元触媒４の上流側に、ＮＯx センサ５と、尿素添加制御弁６とを備えている。ＮＯx センサ５はＮＯx 吸蔵還元型触媒３の直下流側であり、尿素添加制御弁６の上流側に位置する。また、尿素選択還元触媒４の直上流側には触媒入ガス温度センサ７が配置されるとともに、尿素選択還元触媒４の下流側にアンモニアセンサ８が配置されている。

【００４４】ＮＯx センサ５、尿素添加制御弁６、触媒入ガス温度センサ７、アンモニアセンサ８はそれぞれコンピュータからなる制御装置（ＥＣＵ）９に電気的に接続されている。さらに、機関回転数を検出するための回転数センサが設けられ、このセンサもまた制御装置（ＥＣＵ）９に接続されている。

【００４５】これらセンサ等からの情報により、各触媒の状態ひいては内燃機関の運転状態が検出される。そして、これらセンサ等から入力されるデータから内燃機関の運転状態を検出する運転状態検出手段１０が前記制御装置（ＥＣＵ）９のコンピュータ上に実現されている。さらに、検出した運転状態に応じて、前記尿素添加制御弁６に尿素添加指令を出すとともに、添加量を制御する尿素添加量制御手段１１もまた、前記制御装置（ＥＣＵ）９のコンピュータ上に実現されている。なお、尿素添加量制御手段１１により尿素が添加されるとき、その添加中であることを運転者に表示する還元剤インジケータ１２がメーターパネル等１３に設けられている。

【００４６】ＮＯx センサ５は前記ＮＯx 吸蔵還元型触媒３を経由した排気ガス中のＮＯx濃度、すなわち、尿素選択還元触媒４への入ガス中のＮＯx 濃度を検出する。前記尿素添加量制御手段１１は、ＮＯx センサ５により検出されたＮＯx 濃度と、図示しないエアフローメータにより検出された空気量により内燃機関から排出されるＮＯx 量を求め、求められたＮＯx 量から尿素選択還元触媒４に添加すべき尿素量を推定する添加尿素量決定手段を有し、その推定値に従った量の尿素を添加するよう指令する。

【００４７】ここで、尿素量を推定するため、検出したＮＯx 量と添加すべき尿素量との関係を予め定めたマップをＲＯＭに記憶させておくとよい。なお、ＮＯx センサ５の代わりにアクセル開度、ひいては燃料噴射量、機関回転数、ＥＧＲ制御装置によるＥＧＲ量などからＮＯx 量を推定してもよい。また、内燃機関の吸入空気量はエアフローメータでの検出に代えた他の手段、例えば、スロットル開度などによってもよい。

【００４８】触媒入ガス温度センサ７は、尿素選択還元触媒４へ流入する排気ガスの温度を検出する触媒温度検出手段として機能し、この温度から尿素選択還元触媒４の活性化状態を判定することができる。この触媒への入ガス温度が低いときは、触媒の浄化能力が低いので、尿素添加量制御手段１１において、尿素添加量を減らす。

なお、触媒への入ガス温度（触媒温度）と尿素添加量との関係は予めマップとしてＲＯＭに記憶しておく。

【００４９】アンモニアセンサ８は、尿素添加量の補正に使用する。すなわち、尿素選択還元触媒４の下流側にあるアンモニアセンサ８によりアンモニアを検出するということは、ＮＯx 量以上に、添加された尿素が多すぎることを意味する。このため、アンモニアセンサ８で検出したアンモニア検出量を尿素添加量制御手段１１にフィードバックして、添加すべき尿素量を適正な目標値に修正するフィードバック制御手段を備えている。この制御手段もまた尿素添加量制御手段１１の一部として制御装置（ＥＣＵ）９のコンピュータ上に実現されている。

【００５０】以下、本例による排気浄化制御を説明する。内燃機関が運転されると、筒内で燃料が燃焼されることにより、排気ガスが排出され、排出されたガスは排気管２内を流れ、ＮＯx 吸蔵還元型触媒３と尿素選択還元触媒４とを順次通過して図示しないマフラーを通り、大気へと放出される。

【００５１】本例では、ＮＯx 吸蔵還元型触媒３での浄化領域を越えた高負荷高回転の機関運転領域において尿素選択還元触媒４が機能することで、可能な限り広い領域での排気浄化を行う。

【００５２】まず、所定の高負荷高回転領域でない場合、ＮＯx 吸蔵還元型触媒３において、上記した原理でＮＯx の吸蔵と還元が繰り替えされ、排気浄化が行われる。すなわち、ＮＯx 吸蔵還元型触媒３からＮＯx が放出されるとき、流入排気ガスの空燃比をリッチにして、ＮＯx 吸蔵還元型触媒３において放出したＮＯx を還元する。

【００５３】一方、内燃機関が所定の高負荷高回転となった場合に、スロットルを絞り吸入空気量を減らすなどして、空燃比をリッチにすると、吸入空気量（酸素量）が減ることに起因して、燃料が未燃状態となっていわゆるスモークが発生してしまう。よって、所定の高負荷高回転の運転領域ではＮＯx 吸蔵還元型触媒３よるＮＯx の還元を行うことができない。

【００５４】そこで、このような運転領域であることを、運転状態検出手段１０が検出したことを受けて、尿素添加量制御手段１１が前記尿素添加制御弁６に尿素添加指令を出す。尿素添加制御弁６からは尿素水溶液が噴射され、これにより、上記した原理によって、排気浄化がなされる。

【００５５】この間ＮＯx センサ５により、ＮＯx 吸蔵還元型触媒３で浄化されずに吹き抜けたＮＯx の濃度を検出し、この検出値を受けて、制御装置（ＥＣＵ）９の尿素添加量制御手段１１は、ＮＯx 濃度と、内燃機関への吸入空気量により内燃機関から排出されるＮＯx 量を求め、その値から尿素選択還元触媒４に添加すべき尿素量を添加尿素量決定手段によって推定し、その推定値に従った量の尿素を添加するよう尿素添加制御弁６に指令する。

【００５６】また、触媒入ガス温度センサ７により尿素選択還元触媒４への入ガス温度が測定され、その検出値の高低に応じて、制御装置（ＥＣＵ）９の尿素添加量制御手段１１において、尿素添加量を増減する。

【００５７】さらに、アンモニアセンサ８が尿素選択還元触媒４を通過した出ガス中のアンモニア濃度を検出しており、この検出値を受けて、尿素添加量制御手段１１におけるフィードバック制御手段は、尿素選択還元触媒４を通過した排気ガス中のアンモニア濃度が少なくなる方向に、添加尿素量を修正する。

【００５８】このようにして、ＮＯx 吸蔵還元型触媒３と尿素選択還元触媒４とで排気浄化が行われるが、ここで、ＮＯx 吸蔵還元型触媒３と尿素選択還元触媒４による排気浄化の補完関係を図４に示す。図４における（Ａ）はＮＯx 吸蔵還元型触媒３による浄化可能領域を示し、図４における（Ｂ）は尿素選択還元触媒４による浄化可能領域を示す。

【００５９】また、図５に、ＮＯx 吸蔵還元型触媒３と尿素選択還元触媒４における排気温度と浄化率との関係を示す。図５の（Ａ）はＮＯx 吸蔵還元型触媒３による浄化可能領域を示し、図４における（Ｂ）は尿素選択還元触媒４による浄化可能領域を示す。図５から明らかなように排気温度の低い領域でＮＯx 吸蔵還元型触媒３が機能し、排気温度の高い領域で尿素選択還元触媒４が機能することが理解される。

【００６０】なお、本実施形態において、ＮＯx 吸蔵還元型触媒３と尿素選択還元触媒４の位置を交換してもよい。

【００６１】<実施形態２>次に、図６に従って他の実施形態を説明する。図６では、実施形態１で示した構成に、さらに、スタートキャット２１を備えた構成である。スタートキャット２１は、内燃機関にできるだけ近い排気管２内に設けたＮＯx 触媒のことで、機関始動時に、ＮＯx 吸蔵還元型触媒３が暖められる前に内燃機関から出されるＮＯx を浄化する。スタートキャット２１はＮＯx 吸蔵還元型触媒３の前段で内燃機関に近い部分に配置されるため、機関の始動時に排気ガスによって速やかに加熱され、浄化領域に昇温される。

【００６２】<実施形態３>図７に示したように、この実施形態に示した排気浄化装置は、図１に示した構成に加えて、上流側に配置されたＮＯx 吸蔵還元型触媒３を迂回して排気ガスを下流側の触媒に案内するバイパス路３１を有している。

【００６３】排気管２とバイパス路３１との分岐点には、切換手段として、バイパス路３１を開閉することで排気ガス流を切り換える切換弁３２が設けられている。

【００６４】この切換弁３２は、前記制御装置（ＥＣＵ）９に電気的に接続されて制御される電磁弁である。そして、切換弁３２は、運転状態検出手段１０によりＮ

Ox 吸蔵還元型触媒３が機能する運転領域であるとされたとき、バイパス路３１を閉じ、ＮOx 吸蔵還元型触媒３へと排気ガスが流れるようにする。また、内燃機関が高負荷高回転の運転状態となったときは、この状態を検出して切換弁３２でバイパス路３１を開くとともに、ＮOx 吸蔵還元型触媒３への排気ガス通路を閉ざし、排気ガスがバイパス路３１から直接尿素選択還元触媒４へ流入するようにしてある。

【００６５】従って、運転状態検出手段１０で検出した内燃機関の運転状態が高負荷高回転でない場合、制御装置からの指令で切換弁３２がバイパス路３１を閉じ、ＮOx吸蔵還元型触媒３へと排気ガスを流し、運転状態検出手段１０で検出した内燃機関の運転状態が高負荷高回転である場合、制御装置からの指令で切換弁３２がバイパス路３１を開き、ＮOx 吸蔵還元型触媒３への排気ガス流路を閉ざして、排気ガスをバイパス路３１から直接尿素選択還元触媒４へと流す。このような運転領域であることを、運転状態検出手段１０が検出したことを受けて、尿素添加量制御手段１１が前記尿素添加制御弁６に尿素添加指令を出す。尿素添加制御弁６からは尿素水溶液が噴射され、これにより、上記した原理によって、排気浄化がなされる。

【００６６】＜実施形態４＞図８に示したように、この実施形態に示した排気浄化装置は、排気通路を互いに並列な第１の排気通路４１と第２の排気通路４２とに分岐せしめ、第１の排気通路４１にＮOx 吸蔵還元型触媒を配置し、第２の排気通路４２に尿素選択還元触媒４を配置した構成である。

【００６７】そして、前記切換手段として、切換弁３２を前記第１の排気通路４１と第２の排気通路４２との分岐点に配置してある。そして、図１に示した構成と同様に、ＮOx センサ５が尿素選択還元触媒４のの上流側に設けられているとともに、尿素選択還元触媒４の直上流側に触媒入ガス温度センサ７が設けられ、かつ、尿素選択還元触媒４の下流側にアンモニアセンサ８が設けられている。さらに、尿素選択還元触媒４の直上流側に尿素添加制御弁６が設けられている。

【００６８】前記切換弁３２は、前記制御装置（ＥＣＵ）９に電気的に接続されて制御される電磁弁である。そして、切換弁３２は、運転状態検出手段１０によりＮOx 吸蔵還元型触媒３が機能する運転領域であるとされたとき、第１の排気通路４１を選択してＮOx 吸蔵還元型触媒３へと排気ガスが流れるようにする。ＮOx 吸蔵還元型触媒３での排気浄化は上記した通りである。

【００６９】また、内燃機関が高負荷高回転の運転状態となったときは、この状態を検出して切換弁３２が第２の排気通路４２を選択して排気ガスが尿素選択還元触媒４へ流入するようにしてある。尿素選択還元触媒４が選択された場合、尿素添加量制御手段１１が前記尿素添加制御弁６に尿素添加指令を出す。尿素添加制御弁６からは尿素水溶液が噴射され、これにより、上記した原理によって、排気浄化がなされる。

【００７０】〔他の実施の形態〕前述した実施の形態ではは本発明をガソリンエンジン１に適用した例で説明したが、本発明をディーゼルエンジンに適用することができることは勿論である。ディーゼルエンジンの場合は、燃焼室での燃焼がストイキよりもはるかにリーン域で行われるので、通常の機関運転状態ではＮOx 吸蔵還元型触媒３に流入する排気ガスの空燃比は非常にリーンであり、ＮOx の吸収は行われるものの、ＮOxの放出が行われることは殆どない。

【００７１】そこで、ディーゼルエンジンでは、例えば排気再循環装置（いわゆる、ＥＧＲ装置）を導入し、排気再循環ガスを多量に燃焼室に導入することによって、排気ガスの空燃比をストイキまたはリッチにして、触媒に吸収されているＮOx を放出させることができる。

【００７２】

【発明の効果】本発明の内燃機関の排気浄化装置によれば、互いに排気浄化領域を補完しあうＮOx 吸蔵還元型触媒と、アンモニア化合物選択還元触媒とを備えたので、可能な限り広い運転領域での排気浄化を行うことができる。

【００７３】ここで、内燃機関の運転状態を検出する運転状態検出手段を備え、内燃機関の運転状態に従って、前記ＮOx 吸蔵還元型触媒とアンモニア化合物選択還元触媒とのいずれか一方に排気ガス流を切換手段で切り換えることにより、運転状態に応じて最適な触媒を選択できる。

【００７４】さらに、添加アンモニア化合物量決定手段により、前記アンモニア化合物選択還元触媒に流入する排気ガス中のＮOx 量と内燃機関の吸入空気量とから、アンモニア化合物選択還元触媒に添加すべきアンモニア化合物量を容易に決定できる。

【００７５】しかも、アンモニア化合物選択還元触媒から流出するアンモニア化合物をアンモニア化合物検出手段で検出し、この検出したアンモニア化合物検出量から添加すべきアンモニア化合物量を適正な添加量に制御手段で修正するようにすれば、より正確に添加アンモニア化合物量を制御することができ、より効果的な排気浄化を行うことができる。

【図面の簡単な説明】

【図１】 本発明に係る内燃機関の排気浄化装置の第１の実施形態の概略構成図である。

【図２】 吸蔵還元型ＮOx 触媒のＮOx 吸放出作用を説明するための図である。

【図３】 機関から排出される排気ガス中の未燃ＨＣ，ＣＯおよび酸素の濃度を概略的に示す線図である。

【図４】 機関回転数および機関負荷との関係で触媒による排気浄化領域を示したグラフ図である。

【図５】 排気温度と排気浄化率との関係を示す図であ

る。

【図６】 第２の実施形態を示す図である。

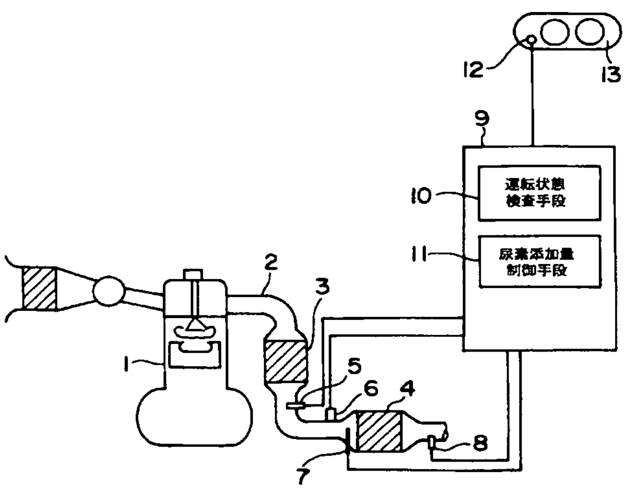
【図７】 第３の実施形態を示す図である。

【図８】 第４の実施形態を示す図である。

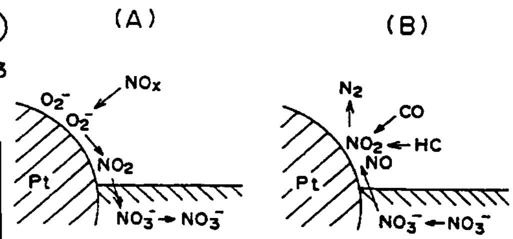
【符号の説明】

1 エンジン
2 排気管
3 吸蔵還元型触媒
4 アンモニア化合物（尿素）選択還元触媒
5 NOx センサ
6 アンモニア化合物添加制御弁（還元剤供給手段）
7 触媒入ガス温度センサ
8 アンモニアセンサ（アンモニア化合物検出手段）
9 制御装置（ＥＣＵ）
１０ 運転状態検出手段
１１ アンモニア化合物（尿素）添加量制御手段
（添加アンモニア化合物（尿素）量決定手段）
１２ 還元剤インジケータ
１３ メーターパネル等
２１ スタートキャット
３１ バイパス路
３２ 切換弁（切換手段）
４１ 第１の排気通路
４２ 第２の排気通路

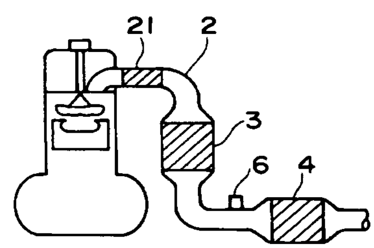
【図１】



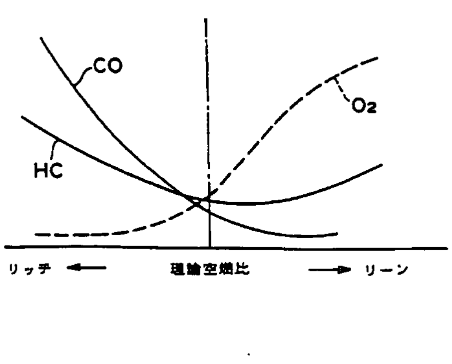
【図２】



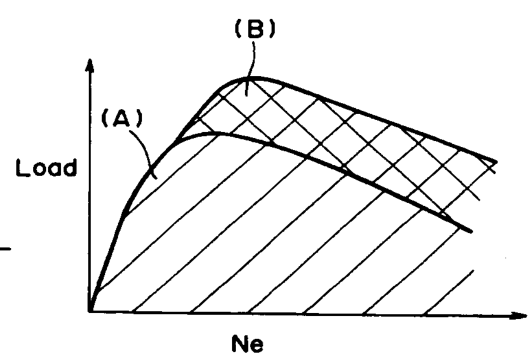
【図６】



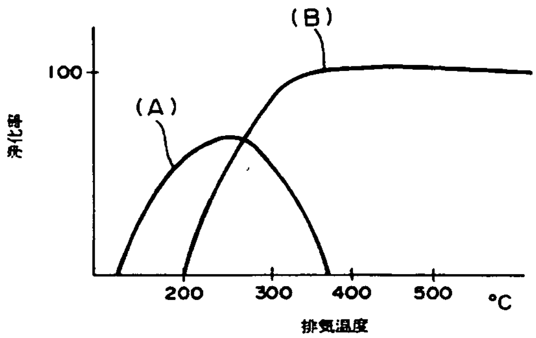
【図３】



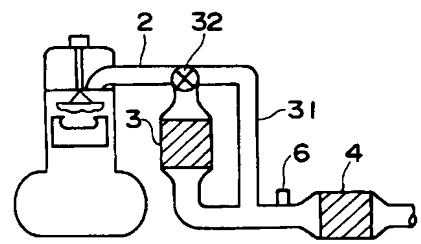
【図４】



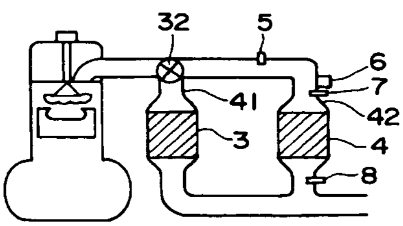
【図５】



【図７】



【図８】



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3/24		１０１Ａ	

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